Cooperative Modeling: An Approach for Community-Based Water Resource Management

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Sandia National Laboratories in Albuquerque, NM has developed a computerized dynamic simulation model of the hydrology, ecology, demography, and economy to help understand and manage the water resources in the Middle Rio Grande Basin (MRGB). The model, built in the commercially-available application Powersim, has a user-friendly interface in which parameters can be varied with slider bars and switches, and provides graphical output projected to the year 2030. It allows water managers, farmers, environmentalists, educators, legislators, and others to work together, ask questions of the model, and get answers in real time that shed light on how the region can preserve water resources.

For example, the model could analyze the impact on regional water resources if every house in the MRGB used low-flow toilets. In the MRGB, water for indoor uses comes from the aquifer in the Albuquerque Basin. Once used, that water is returned to the river through various sewage treatment plants. A reduction in indoor uses reduces the rate of aquifer depletion, but it also reduces river discharge; furthermore, retrofitting homes with low-flow toilets has economic impacts. The model illustrates all these relationships and allows the tradeoffs associated with them to be quantified.

The model illustrates and quantifies relationships between surface water, groundwater, and costs for many other alternatives as well, such as improving the irrigation efficiency in the Middle Rio Grande by lining irrigation ditches and laser-leveling fields, reducing evapotranspiration in the riparian forest by removing exotic phreatophytes, changing water pricing rates, or having the City of Albuquerque begin taking surface water from the Rio Grande.

The values that are obtained from the model are based on historic data that feed into the model, the current understanding of basin hydrology and ecology, and probabilistic projections made into the future, all of which carry certain uncertainties. In spite of those uncertainties, the magnitude of impacts and the effects throughout the system are clearly shown.

Models like this are not new, but one of the problems associated with them has been their inaccessibility to water managers, policy makers, and the public. Sandia's approach of "cooperative" modeling incorporates a team of farmers, developers, environmentalists, lawyers, engineers, and water managers, almost all of the major stakeholders in the basin, to build and refine the model.

The stakeholder team for the MRGB analysis arose from the water planning process currently administered by the Middle Rio Grande Water Assembly (MRGWA) and the Mid-Region Council of Governments (MRCOG). These groups, along with the Utton Transboundary Resources Center, are working together to provide the water plan requested by the New Mexico Office of the State Engineer by the summer of 2003.

Through long-term cooperative involvement in the model development process, the stakeholder team learns the structure, assumptions, limitations, and strengths of the model. Continued dialogue with city, state and federal water management agencies in the region helps to further refine the model. Through this community-level development, the model has a greater chance to be more widely accepted and used.

The cooperative modeling process provides a bridge between the technical demands and capabilities of a rigorous, quantitative model, and the collaborative social processes required for natural resource management. By bridging the two, Sandia hopes to contribute to water resource sustainability in the Middle Rio Grande Basin and beyond.

For more information, visit www.sandia.gov/water

Digital Library Focusing on Western Waters is Under Construction

The Western Waters Digital Library (WWDL) is an institutional group effort that will focus on the great rivers of the West, with initial concentration on the Colorado, Columbia, Platte, and Rio Grande. The focus will not only be on the rivers themselves, but the interplay of the rivers on human development throughout the drainage basins they have formed. All four rivers begin high in the Rocky Mountains and, along with their tributaries, form the lifelines of the communities that have grown up around them, supplying drinking water, fisheries, irrigation water for farming and ranching, recreation, and waste disposal. The scenic canyons these rivers have formed, and the rock faces they have left behind, help explain the nature of hydrological forces. The WWDL will address all of these factors in an attempt to document the defining issue of the Western United States.

The project involves 28 academic and one special research library, all members of the Greater Western Library Alliance, the agency sponsoring the project. To date, the following institutions have submitted collections to be included in the digital library: Arizona State University; University of Arizona; University of Nebraska-Lincoln; University of Nevada Las Vegas; University of Nevada, Reno; University of New Mexico Center for Southwest Research; University of Oregon; University of Southern California, Los Angeles; University of Utah; and University of Washington.

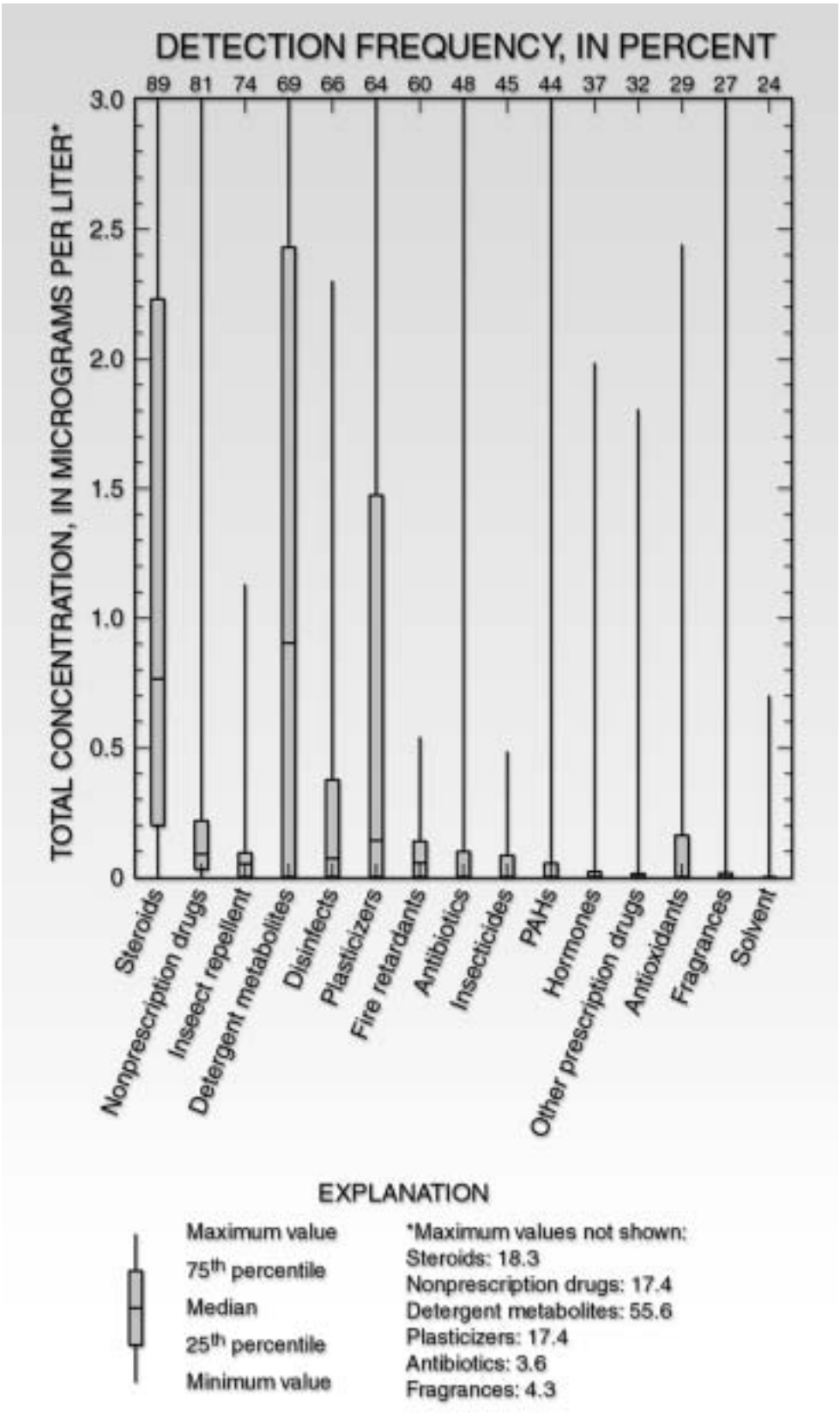
Visit http://www.westernwater.org/prospectus.html

Pharmaceuticals, Hormones, and Other Organic Constituents Detected in Effluent-Dominated Streams

A recent study by the U.S. Geological Survey found low concentrations of pharmaceuticals and other organic wastewater contaminants (OWCs) in seven effluent-dominated streams in the Southwest. The samples were part of a national study looking at the detection of pharmaceuticals, hormones, and other organic wastewater-related chemicals in streams. A report on the study, USGS Open-File Report 02-94, "Water-Quality Data for Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000," can be found on the web at toxics.usgs.gov/pubs/OFR-02-94/.

Nationally, 139 sites were sampled from streams known to have a wastewater component. In the semi-arid Southwest, where effluent-dominated streams may have no dilution from non-wastewater sources, only four streams from Arizona and three from southern California were sampled. Each site in the study was sampled once.

Samples were analyzed for 95 wastewater-related compounds, 81 of which do not have drinking-water standards or health advisories; many are known endocrine disruptors. Nationally, at least one OWC was detected in 80 percent of the samples, and 82 of the 95 compounds were detected at least once. The most frequently detected compounds included steroids (including cholesterol), non-prescription drugs (including caffeine, nicotine metabolites, and pain-relievers), and DEET, the active ingredient in many insect repellants. Detergents, steroids, and plasticizers generally were detected at the highest concentrations, however the concentrations measured in this study were generally less than 1 part per billion (ppb). Various antibiotics were detected in more than 50 percent of the samples.



Frequency of detection of chemical groups most commonly detected in susceptible streams. From U.S. Geological Survey Fact Sheet FS-027-02, available at toxics.usgs.gov/pubs/FS-027-02.

In Arizona, the four streams sampled include the Santa Cruz River near Rio Rico (near the Mexico border), the Santa Cruz River at Cortaro Road in Tucson, the 91st Avenue sewage treatment plant outfall in Phoenix, and the Gila River

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above the diversions at Gillespie Dam. Fourty eight analytes were detected at least once in the Arizona samples. Thirty seven compounds were detected in the Cortaro Road sample; the highest number of compounds detected nationally in any one sample was 38. Fourteen compounds were detected at the highest concentration nationwide in Arizona samples, including several antibiotics and other prescription drugs, pesticides, DEET, and a nicotine metabolite.

The three southern California streams that were sampled are San Timoteo Creek near Yucaipa, Cucamonga Creek wastewater effluent at Chino Avenue near Ontario, and Inland Empire wastewater effluent to Cucamonga. The samples from southern California showed generally lower concentrations than those from Arizona. Twenty-four compounds were detected in both the Yucaipa and Ontario samples, with different combinations in each. Nine compounds were detected in the Inland Empire sample, but more than half of the total list of compounds were not analyzed in that sample. The Yucaipa sample had the highest concentration of one insecticide and one antidepressant in the nation.

Gail Cordy, a supervisory hydrologist at the USGS Water Resources Division in Tucson, is now working with Dr. Herman Bouwer and other scientists at the U.S. Water Laboratory in Phoenix to investigate which OWCs could be expected to persist during recharge of treated effluent. They are performing tests in which treated effluent is allowed to pass through columns of natural desert soil, and the discharge is monitored for OWCs. Preliminary results indicate the persistence of a nicotine metabolite, two antibiotics, and carbamazapine (an antiepileptic), along with DEET and a few other compounds. The team plans to continue their investigation of the persistence of OWCs by testing effluent released from soil columns planted with various crops irrigated at different efficiencies, all grown with treated effluent.

In addition, the USGS sampled ten wells owned by the City of Tucson and Pima County Wastewater Management, located along the Santa Cruz River, to analyze for the presence of OWCs in groundwater. Finally, they plan to collect more samples from the Cortaro Road site to improve their understanding of the spatial and temporal persistence and fate of the OWCs. Additional locations upstream and downstream of the original site will be sampled, and bed sediment will also be collected.

Reports on the USGS investigation can be found at toxics.usgs.gov/regional/emc_surfacewater.html. Contact Gail Cordy at gcordy@usgs.gov.